Geophysical Research Abstracts
Vol. 16, EGU2014-12168, 2014
EGU General Assembly 2014

Stable isotope-based Plio-Pleistocene ecosystem reconstruction of some of the earliest hominid fossil sites in the East African Rift System (Chiwondo Beds, N Malawi)

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The isotope geochemistry of pedogenic carbonate and fossil herbivore enamel is a powerful tool to reconstruct paleoenvironmental conditions in particular when climate change plays a key role in the evolution of ecosystems. Here, we present the first Plio-Pleistocene long-term carbon (δ13C), oxygen (δ18O) and clumped isotope (Δ47) records from pedogenic carbonate and herbivore teeth in the Malawi Rift. These data represent an important southern hemisphere record in the East African Rift System (EARS), a key region for reconstructing vegetation patterns in today's Zambezian Savanna and correlation with data on the evolution and migration of early hominids across the Inter-Tropical Convergence Zone. As our study site is situated between the well-known hominid-bearing sites of eastern and southern Africa in the Somali-Masai Endemic Zone and Highveld Grassland it fills an important geographical gap for early hominid research.

5.0 to 0.6 Ma fluviatile and lacustrine deposits of the Chiwondo Beds (NE shore of Lake Malawi) comprise abundant pedogenic carbonate and remains of a diverse fauna dominated by large terrestrial mammals. These sediments are also home to two hominid fossil remains, a mandible of Homo rudolfensis and a maxillary fragment of Paranthropus boisei, both dated around 2.4 Ma. The Chiwondo Beds therefore document early co-existence of these two species.

We evaluate δ13C data from fossil enamel of different suid, bovid, and equid species and contrast these with δ13C and δ18O values of pedogenic carbonate. We complement the latter with clumped isotope soil temperature data. Results of almost 800 pedogenic carbonate samples from over 20 sections consistently average δ13C = -8.5 ‰ over the past 5 Ma with no significant short-term δ13C excursions or long-term trends. The data from molar tooth enamel of nine individual suids of the genera Metridiochoerus, Notochoerus and Nyanzachoerus support these findings with average δ13C = -10.0 ‰The absence of long-term trends towards more positive δ13C values contrasts the increasing role of C4-grasslands in the southern EARS which is well documented for sites in Ethiopia, Kenya and Tanzania. Our data hence point to regional differences in climate and vegetation dynamics during the Plio-Pleistocene in the EARS and documents persistence of paleoenvironmental conditions in the southern branch of the EARS at times of early hominid evolution.